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ADVANCED ANALOG

MODELS 414/416/418
HIGH RESOLUTION D/A CONVERTERS

DESCRIPTION

Function Modules 414/416/418 family of low-cost, high-performance 14 bit binary, 16 bit binary, 4 digit BCD or ±4-1/2 digit BCD Digital-to-Analog Converters is designed for accurate and reliable performance, with adjustment free but versatile operation. Each converter is completely self-contained and ready to operate in a 2" X 3" X 0.4" package with built-in temperature compensated reference network, ±2ppm/°C binary or BCD weighted wire wound resistor network, fast current switches, and output amplifier.

The binary Models 414-BIN and 416-BIN both offer external selectable output options. Either current output or voltage output can be obtained by selecting the appropriate pins. These binary versions are also capable by pin selection to accept either straight binary input for unipolar operation or offset binary input for bipolar operation. Two's complement coding can also be obtained by driving the MSB (Most-Significant-Bit, Bit 1) with a complement input ($\overline{MSB}$).

The BCD Model 416-BCD is a 4 digit unipolar DAC with both current or voltage outputs available. The Model 418-BCD is a ±4-1/2 digit bipolar DAC with only voltage output available. Full scale output ranges for the 414-BIN and 416-BIN are 0 to +2mA or ±1mA in the current output mode and 0 to -10V, ±5V or ±10V at 5mA is available in the voltage mode. The full scale output range for the 416-BCD is 0 to +1.25mA in the current mode and 0 to -10V at 5mA in the voltage mode. The Model 418-BCD will provide ±10V at 5mA.

While an internal reference is included in each model, provisions have been made for the use of an external reference. This feature is useful in systems where several DAC's must track closely over a wide temperature range. For more detailed information, see Functional Block diagram on page 3.

The low nonlinearity drift, small size and versatility of operation makes this low-cost converter family a best buy in high performance D/A Converters.

FEATURES

- Current or Voltage Output
- 14 and 16 Bits Binary
- 4 and ±4-1/2 Digits BCD
- Low Nonlinearity and Nonlinearity Drift
- Low Cost
- And they're only 2" X 3" X 0.4"!

MODEL NUMBER TABLE

Model	Resolution	Nonlinearity	Vs Temperature	Price
414-BIN	14 Bit Binary	±0.003%	±3ppm/°C	
416-BIN	16 Bit Binary	±0.002%	±2ppm/°C	
416-BCD	4 Digit BCD	±0.005%	±3ppm/°C	
418-BCD	±4-1/2 Digit BCD	±0.003%	±3ppm/°C	

SPECIFICATIONS

(Typical at +25°C and rated power supplies unless otherwise noted.)

MODEL	414-BIN	416-BIN	416-BCD	418-BCD
RESOLUTION	14 Bit Binary	16 Bit Binary	4 Digit BCD	±4-1/2 Digit BCD
ACCURACY				
Nonlinearity	±0.003%	±0.002%	±0.005%	±0.005%
Scale Factor(1), Voltage	±0.02%	±0.02%	±0.02%	±0.02%
Offset(1)	±2mV	±2mV	±2mV	±2mV
STABILITY				
Nonlinearity	±3ppm/°C	±2ppm/°C	±3ppm/°C	±3ppm/°C
Scale Factor	±7ppm/°C	±7ppm/°C	±7ppm/°C	±10ppm/°C
Offset				
Unipolar	±3ppm/°C	±2ppm/°C	±2ppm/°C	N/A
Bipolar	±7ppm/°C	±5ppm/°C	N/A	±5ppm/°C
Power Supply Rejection	±0.005%/%ΔV_S			
SETTLING TIME	100 μsec to within ±0.002% of final value			
ANALOG OUTPUT RANGES				
Unipolar				
Current	0 to +2mA		0 to +1.25mA	0 to +2mA
Voltage	0 to −10V		0 to −10V	N/A
Bipolar				
Current	−1mA to +1mA		N/A	N/A
Voltage	±5V & ±10V		N/A	±10V
Loading				
Current	±1V compliance			
Voltage	±5mA			
DIGITAL INPUTS				
TTL & CMOS Compatible				
"0"	0 to 0.8V			
"1"	+2.4V to +15V			
INTERNAL REFERENCE	-6.2V nominal			
TEMPERATURE RANGE				
Rated	0°C to +70°C			
Operating	-25°C to +85°C			
Storage	-55°C to +100°C			
POWER REQUIREMENTS				
Voltage	±15V			
Current	±25mA			
PACKAGE	2" X 3" X 0.4"			

(1) Both Scale Factor and Offset can be externally adjusted to eliminate any initial errors. Double error when connected for bipolar operations.

OPERATION

Figures 1 and 2 are the Functional Block Diagrams for the 414, 416 and 418. The reference network provides a stable voltage for the weighted current sources. If an external reference is not being used, the REF IN (pin 34) must be connected to REF OUT (pin 32) for proper operation. It is recommended to drive the REF IN from an operational amplifier or other low impedance source when using an external reference. When each current source has its' control input (bit input) connected to a Logic "1" level, that current source's contribution will appear on the current output summing bus I OUT (pin 50).

The 414 and 416 can be selected for either voltage or current mode of operation. If a voltage output is desired, simply connect the I OUT (pin 50) to the amplifier summing junction, SJ, (pin 52). For a current output, leave pin 52 open and use the current output, I OUT, (pin 50). However, the maximum output voltage compliance of the current source's is ±1V, which means the maximum resistance to ground is 1V ÷ 2mA ≃ 500Ω for unipolar operation and ±1V ÷ ±1mA ≃ 1KΩ for bipolar operation. To select bipolar operation connect the MODE output (pin 51) to I OUT (pin 50). This provides a negative current equal to the MSB (bit 1) that offsets the output. When operated in the unipolar mode, the MODE output (pin 51) must be connected to system ground to maintain the proper loading levels within the module.

The binary versions have two output ranges selectable by external connections. For a 10V output range, connect 10V RANGE (pin 56) to V OUT (pin 48), and for a 20V output range connect 10V RANGE (pin 56) to the system analog ground.

The 418-BCD is fundamentally in a voltage mode of operation. It can, however, be operated in a current mode, but the polarity or sign bit cannot be used and the output will be unipolar only. For voltage operations, connect I OUT (pin 50) to SUMMING JUNCTION (pin 52). V OUT (pin 55) is the bipolar output.

CODING

Full scale output for the Models 414/416/418 is determined by external pin connections. The coding table below illustrates the Analog Output versus the Digital Input and the least-significant-bit (LSB) weights for each converter.

	Analog Output	BITS (Digital Input) POLARITY (418-BCD only)	OVERRANGE (418-BCD only)	MSB	2SB	3SB	4SB	(N-3) LSB	(N-2) LSB	(N-1) LSB	LSB
Unipolar – Straight Binary Models 414-BIN 416-BIN	-(F.S. -1 LSB)			1	1	1	1	1	1	1	1
	-1/2 F.S.			1	0	0	0	0	0	0	0
	-1 LSB			0	0	0	0	0	0	0	1
	0			0	0	0	0	0	0	0	0
Bipolar – Offset Binary Models 414-BIN 416-BIN	-(F.S. -1 LSB)			1	1	1	1	1	1	1	1
	-1/2 F.S.			1	1	0	0	0	0	0	0
	-1 LSB			1	0	0	0	0	0	0	1
	0			1	0	0	0	0	0	0	0
	+1 LSB			0	1	1	1	1	1	1	1
	+1/2 F.S.			0	1	0	0	0	0	0	0
	+F.S.			0	0	0	0	0	0	0	0
Unipolar – BCD Model 416-BCD	-(F.S. -1 LSB)			1	0	0	1	1	0	0	1
	-1/2 F.S.			0	1	0	1	0	0	0	0
	-1 LSB			0	0	0	0	0	0	0	1
	0			0	0	0	0	0	0	0	0
Bipolar – BCD Model 418-BCD	+(F.S. -1 LSB)	1	1	1	0	0	1	1	0	0	1
	+1/2 F.S.	1	1	0	0	0	0	0	0	0	0
	+1 LSB	1	0	0	0	0	0	0	0	0	1
	0	1	0	0	0	0	0	0	0	0	0
	-1 LSB	0	1	0	0	0	0	0	0	0	1
	-1/2 F.S.	0	1	0	0	0	0	0	0	0	0
	-(F.S. -1 LSB)	0	1	1	0	0	1	1	0	0	1

NOTES:

1. The Least-Significant-Bit (LSB) weights are:

	No. of Steps	LSB For 10V Span	LSB For 20V Span
414-BIN	16384	0.61mV	1.22mV
416-BIN	65536	0.15mV	0.30mV
416-BCD	9999	1.00mV	–
418-BCD	±19999	–	0.5mV

2. The 414-BIN and 416-BIN can be connected for a full-scale (F.S.) output voltage of -10V for unipolar operation and ±5V or ±10V for bipolar operation. The 416-BCD full-scale (F.S.) output voltage is -10V, and the 418-BCD is ±10V.

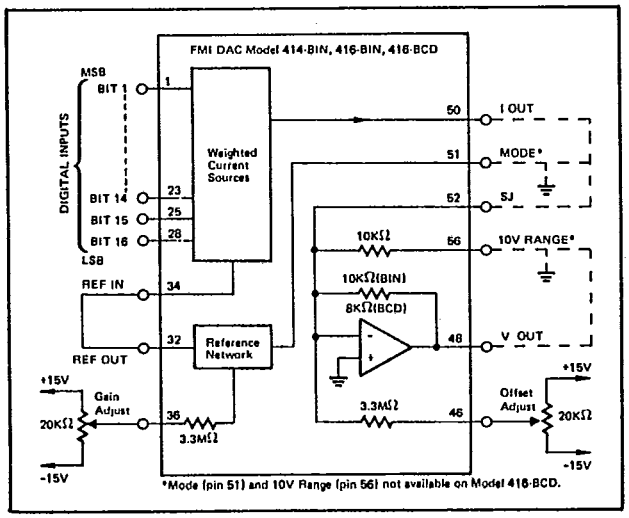


Figure 1. Functional Block Diagram of 414 & 416

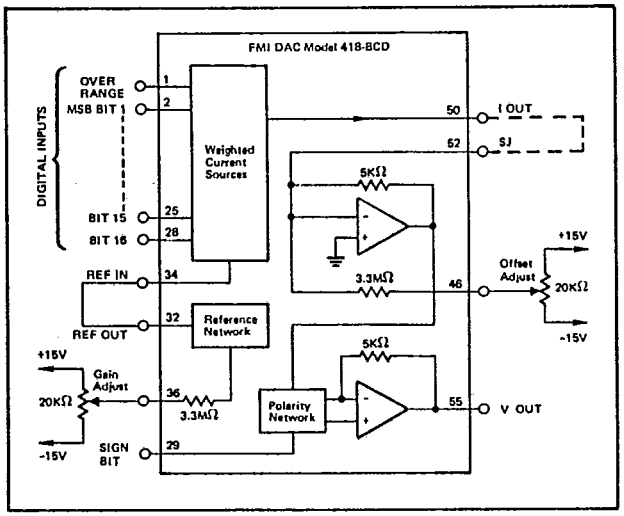
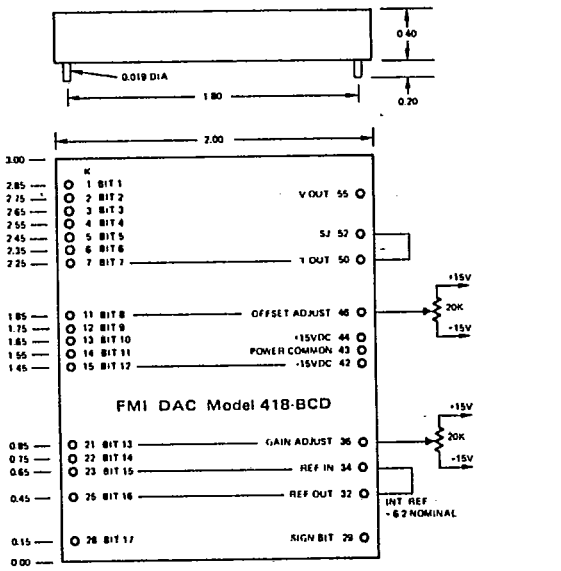
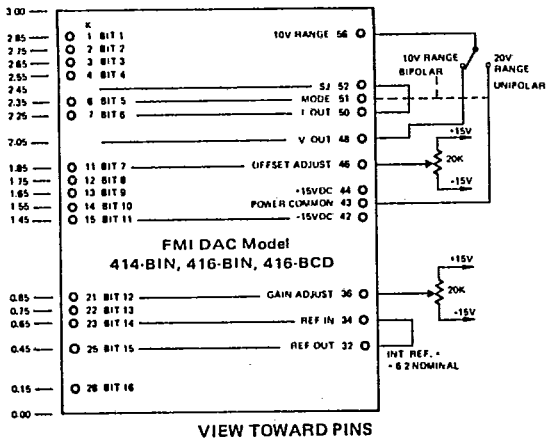


Figure 2. Functional Block Diagram 418

OUTLINE DIMENSIONS





VIEW TOWARD PINS

CASE: Black – Diallyl Phthalate
PINS: Gold Flashed over Silver Plated 1/2 Hard Brass
WEIGHT: 3.0 oz.

PIN CONNECTIONS

1. For unipolar operations connect MODE (pin 51) to COMMON (pin 43).
2. For bipolar operation connect MODE (pin 51) to I OUT (pin 50).
3. MODE pin not available on 416-BCD or 418-BCD.
4. For current output use I OUT (pin 50).
5. For voltage output connect I OUT (pin 50) to SJ (pin 52). Use V OUT (pin 48) for Models 414 and 416, and use V OUT (pin 55) for Model 418.
6. For 20V span, connect 10V RANGE (pin 56) to COMMON (pin 43). For 10V span, connect 10V RANGE (pin 56) to V OUT (pin 48). 10V RANGE (pin 56) not available on Model 416-BCD or Model 418-BCD.
7. When using internal reference, connect REF OUT (pin 32) to REF IN (pin 34).
8. The logic input ground must also be referenced to the ±15V analog common.

OPTIONAL EXTERNAL ADJUSTMENTS

OFFSET ADJUST

As a user option, the output offset voltage can be adjusted by connecting the wiper of a 20KΩpot with ±15V excitation voltage to the OFFSET ADJUST (pin 46). This will provide approximately ±45mV of adjustment. If finer adjustment is desired, then the range of adjustment can be reduced by adding an external resistor in series with the pot wiper and the internal 3.3MΩ resistor. Pin 46 should be connected to analog common if an adjustment is not needed. See Functional Block Diagram for details.

GAIN ADJUST

The gain, or scale factor, may also be externally adjusted. A 20KΩ trim pot with excitation voltage of ±15V and the wiper connected to GAIN ADJUST (pin 36) will provide approximately ±0.5% range of adjustment. If finer adjustment is desired, then the range of adjustment can be reduced by adding an external resistor in series with the pot wiper and the internal 3.3MΩ resistor. Pin 36 should be connected to analog common if an adjustment is not needed. See Functional Block Diagram for details.

ORDER OF ADJUSTMENT

The proper procedure for the optional external offset and gain adjustment is as follows:

Unipolar Operation – With an all digital "0" input, adjust offset control for zero output. Then with all digital "1" inputs, adjust GAIN control for minus full scale output less one least-significant-bit (-(F.S. -LSB)) for binary.

Bipolar Operation – With an all digital "0" input, adjust OFFSET control for plus Full Scale (+5V for 10V span or +10V for 20V span). Then with all digital "1" inputs, adjust GAIN control for minus full scale less one least-significant-bit (-(F.S. -LSB)). This sets the correct output span by setting the end points. If it is desired to obtain zero output for a "100....0000" input (offset binary), adjust the OFFSET control for zero output for this input word.

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